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THE MYTH OF THE VANISHING DEFENSE RESOURCE
THE IMPACT OF DEFENSE SPENDING ON THE AMERICAN ECONOMY

by

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There has been much discussion of late about the impact of Defense spending on the American economy. Quickly rising expenditure levels on defense are blamed, in part, for the expected level of the federal government deficit, and the resultant panic in the financial markets. Defense spending, in many people's eyes, is considered to be a waste of scarce economic resources at a time when we can ill afford to waste resources. I will try to discuss the impact on the economy of defense spending from the point of view of an economist rather than of a politician. Politicians and political appointees make judgments as to relative worth of social programs and defense programs. I have tried here, to examine the impact of defense expenditures on the economy in a way that is not biased by any preconceived judgements. This defense of our expenditures on national defense, should not be taken then as a criticism of our expenditures on social programs. This paper is solely my own opinion. It in no way reflects the views of the US government or the Department of Defense.

Adequacy of US Industrial Base

There is a prevalent theory, promoted in part by articles appearing in the popular press, that the American industrial base is today inadequate to the job of building the weapons systems that the Reagan administration is proposing to buy over the next few years. I believe, however, that with proper warning American industry can meet the challenge posed. When properly motivated, our industry will easily achieve the production goals embodied within the Reagan program. Moreover new production technologies are fast becoming available that can revolutionize the way we make goods.

I am an optimist I believe our technological base, in place and under development, will be adequate to insure that both defense and civilian requirements will be met. Further, the contemplated expansion in defense, combined with the Reagan tax cuts designed to stimulate demand, increase supply and encourage more individual initiative and savings for business -- the Federal Reserve Board willing -- should stimulate US industry to continue to modernize and to retool so as to meet our growing defense requirements without missing opportunities in the growing civilian market place.

Myth of the Vanishing Defense Resource

There is a single myth that is associated with defense spending and its burden on the economy that needs to be aired here. I have heard it said once, and I have heard it said a hundred times, from many different sources, and in many different words--expenditures on national defense are themselves highly inflationary primarily because goods and/or productive services are removed by the government from the private economy without any additional goods or services being added. I call this concept of resource allocation the Myth of the Vanishing Defense Resources. It is, I am afraid, an argument more akin to the 16th century than to the 20th century. It is an argument dependent upon an economic model that is based upon a simplified, free market, almost agrarian society; and it does not fit today's differentiated, complicated, quasi-free market, advanced-technological state.

How Inflationary is Additional Defense Spending?

To see just how inflationary higher real expenditures on defense would be, and to try to dispose of the myth itself, I sponsored as part of last Fall's OSD Cost Analysis Research Symposium a session on the subject of the impact of higher levels of defense expenditures on the United States economy. That meeting brought together Lawrence Klein, last year's noble prize laureate in economics and Chairman of Wharton Econometric Forecasting Associates; Otto Eckstein, a former member of the President's Council of Economic Advisors and President of Data Resources Inc., the country's largest economic forecasting company; Michael Evans, an outspoken proponent of supply-side economics, former President of Chase Econometrics and currently President of Evans Economics; Leon Taub, Senior Economist of Chase Econometrics and Chase's primary economic forecaster, and Gary Ciminero, the senior macroeconomic forecaster for Merrill-Lynch Economics. All five of these participants essentially agreed that added spending on defense would not, by itself, be very inflationary for the economy. Nor would that spending level today tax the industrial capabilities of the nation as a whole. All five warned, as economists are wont to warn, against excessive deficit financing at a time when monetary discipline is being strictly enforced by the federal reserve.

Otto Eckstein in his presentation perceptively suggested that if defense spending were to expand, while non-defense spending continued to grow unchecked, (or federal revenues were significantly reduced), and if the Federal Reserve Board failed to monetize the resulting federal deficit, then the result would be significantly higher interest rates and all the negative consequences for capital investment and long term economic growth that such higher rates entail. In Otto's words - "You would have a mess." Despite this dire warning, none of the forecasters found inflation to be a natural byproduct of rapid (a real 10% each year), and sustained, defense growth.

Charts 1 and 2 compare the results obtained by the five participants in the symposium. It is clear that either in the case of a compensated increase in defense expenditures--where other programs are reduced or federal taxes are increased (Chart 1); or in the case of the uncompensated increase (Chart 2)--where only defense spending is increased without other cuts or new revenue sources found, the impact on the US inflation rate is not very significant.

It has been clear to me for some time that macroeconomic models do not shed as much light as we would like to have on the true questions embodied in the resource allocation questions at hand. To truly assess the value of, or consequences of, alternative resource uses within an economy as large and diverse as that of the US then other, more complicated modeling system, may have to be utilized.

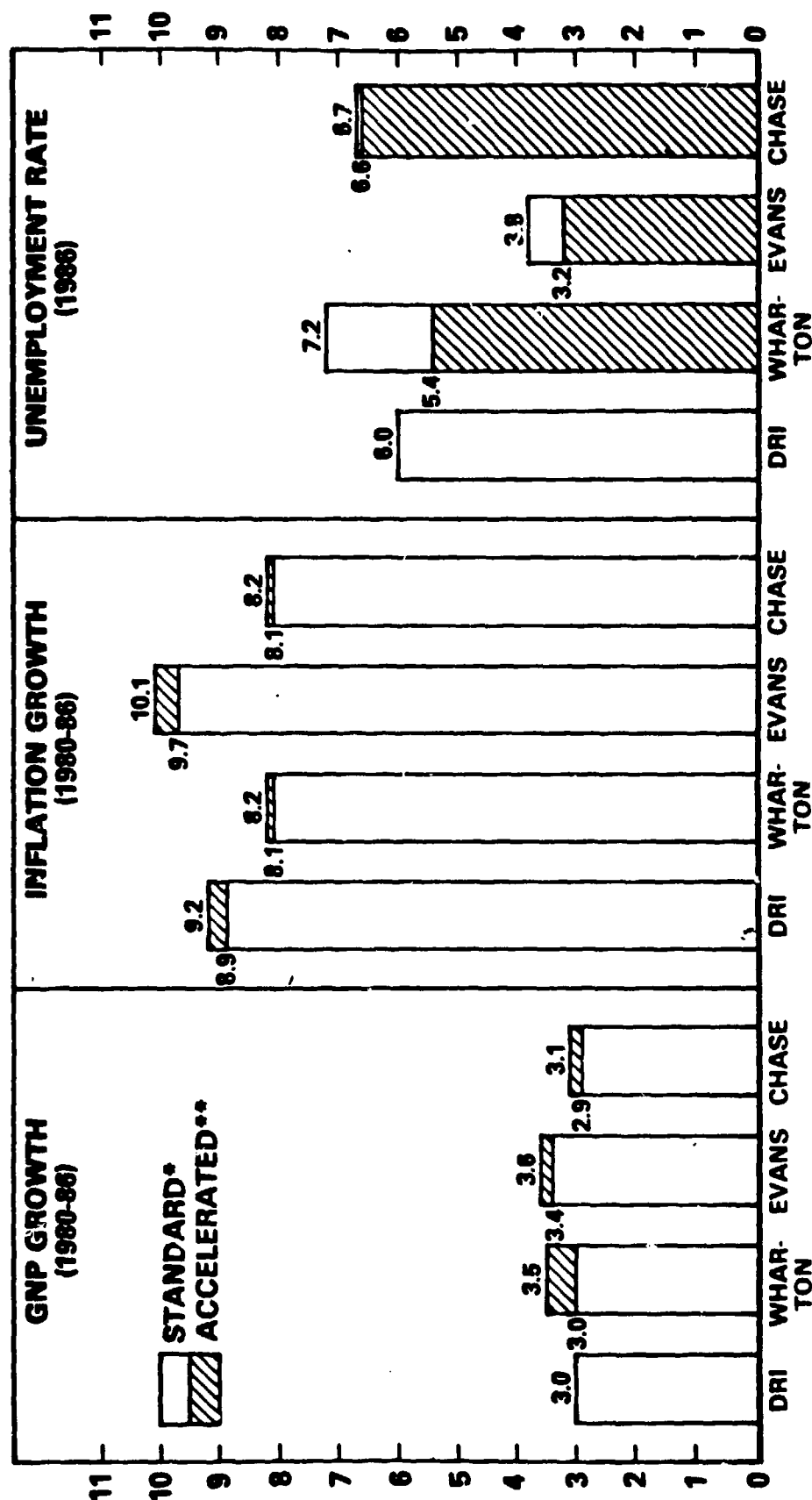
Long leadtimes in some industries have often accompanied even modest increases in defense spending. These leadtimes are due to the pyramding of defense orders for aircraft on non-defense orders for commercial jets, to a failure of communications within an oftentimes segmented industrial market place, and to a pattern of decapitalization in many of our older, dirtier, noisier, and less profitable heavy industrial sectors. Some of the publicized bottlenecks are due to overloading, for example, of a single large press (purchased for the Korean War by the Government and leased to private sector); or to antiquated guild prohibitions against transfers of one of a kind special tools and die sets between competing firms. In the forging industry, for example, many smaller companies have left the business fie to the imposition of strict and costly to overcome environmental rules and regulations. Finally, defense business has appeared to many firms as being too difficult to obtain, too complicated to be worth the effort to qualify; too variable and uncertain to repay the commitment of capital and marketing effort; and too unprofitable once the contract is in hand.

The Defense Economic Impact Modeling System Explained

To understand better the impact of defense spending on the economy, we have developed commodity-specific modeling capabilities. The Defense Economic Impact Modeling System, DEIMS, is probably the largest set of fully integrated econometric models in use for realtime policy analysis in the world today. It allows the Department to analyze the defense budget, now disaggregated into yearly outlays by 4 digit Standard Industrial Classification categories, using a large-scale macroeconomic model; a very detailed producer price modeling system; and a 400 sector, commodity based dynamic input-output model. Output from this last model is then utilized in a 72 skill and 74 commodity-class skilled-labor-demand model, and also in a 62 commodity, quantity based, strategic-materials-requirements model. As a result the US government has available to it today a fully integrated system of models capable of relating

RESULTS OF THE SYMPOSIUM ON THE IMPACT OF HIGHER LEVELS OF DEFENSE SPENDING ON THE ECONOMY

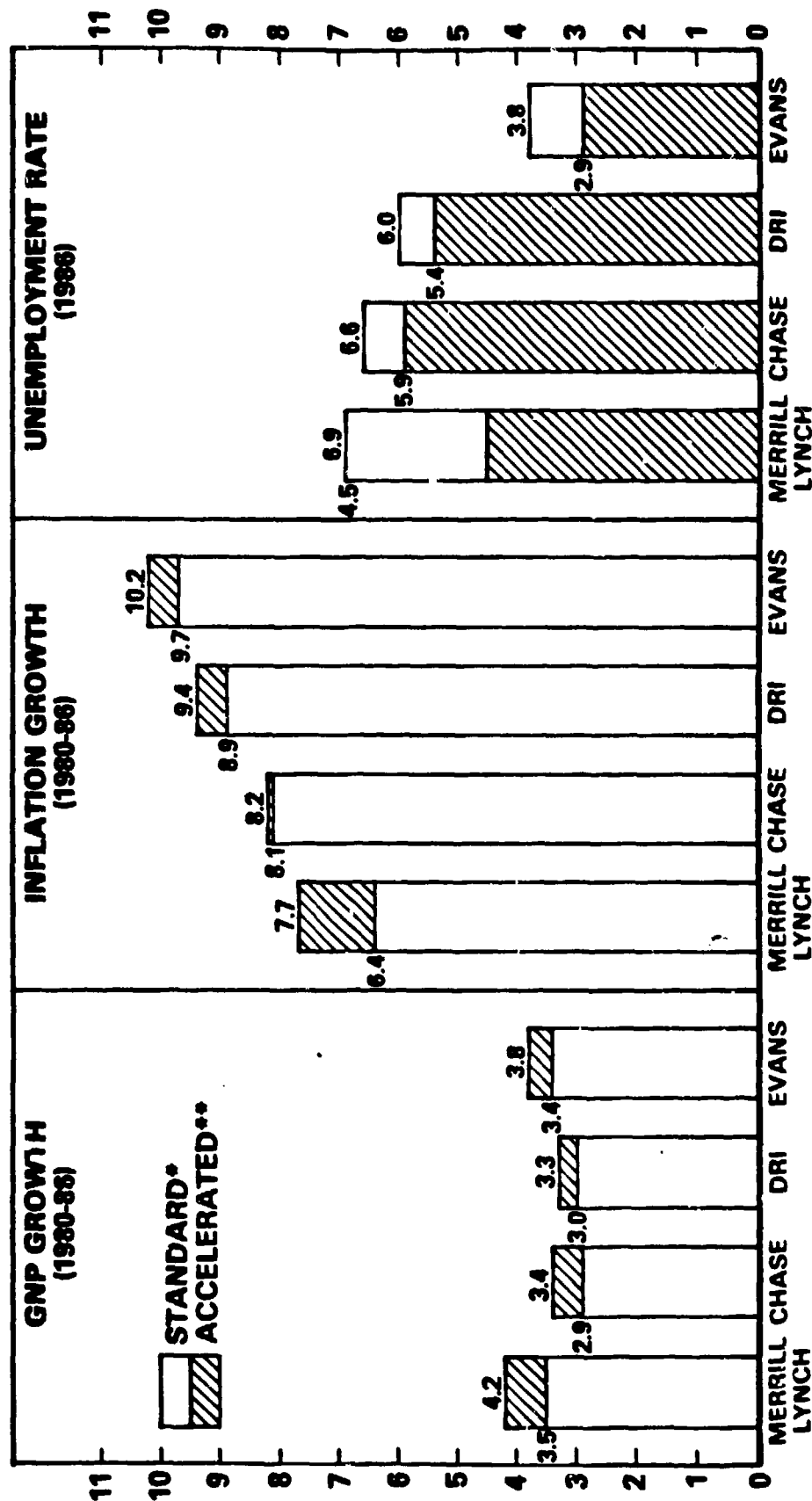
THE IMPACT OF HIGHER DEFENSE EXPENDITURES ON THE US ECONOMY SUMMARY OF MODEL RESULTS COMPENSATED



* 4% REAL GROWTH DEFENSE EXPENDITURES
** 10% REAL GROWTH DEFENSE EXPENDITURES

RESULTS OF THE SYMPOSIUM ON THE IMPACT OF HIGHER LEVELS OF DEFENSE SPENDING ON THE ECONOMY

THE IMPACT OF HIGHER DEFENSE EXPENDITURES ON THE US ECONOMY SUMMARY OF MODEL RESULTS UNCOMPENSATED CASE



* 4% REAL GROWTH DEFENSE EXPENDITURES

** 10% REAL GROWTH DEFENSE EXPENDITURES

4

fiscal policy and monetary policy initiative with changes in the defense bill of goods required year-by-year. Results allow the Department to analyze industrial sector demands, labor skill requirements, and our need for raw materials, all within a fully consistent framework for economic analysis.

Using DEIMS, the department can analyze the resource requirements implied by its prospective budget. Alternative budgets can also be tested using these modeling tools; thus potential problem areas can be highlighted. Results can be used by governments, by industry, and by educational training institutions.

The Civilian Market Place

Economists believe that the best way to influence market place behavior is to send proper signals as to demand expected. The approach I have taken in order to insure that an adequate industrial capacity will be available to meet future defense demands for resources is to provide the best quality forecasts of our future requirements freely to private sector concerns in advance of our orders. Our purpose then is to indicate, to the market which sectors are likely to be the fastest growing; which professions should be in the greatest demand; and which strategic materials could well be consumed in record quantities.

The aim is to interest companies in competing for our business within this growing defense market place. Companies selling products to defense may also utilize this information in order to better plan their capital requirements so that future periods of growth can be anticipated and capital can be in place, and ready, when it is needed. As more firms seek, and win, defense contracts--directly or as sub-contractors for primes--they will be forced to improve their quality control and to update their technology bases. Both of these steps insure such firms will be healthier and more dynamic and thus will be capable of selling to domestic buyers, the government, and even into foreign markets. The result should be a more dynamic US industrial base. Finally, as more jobs are created, the economic health of the nation will improve.

Employment Impact, Productivity Trends and Program Stability

One argument against spending more on defense is that it does not employ as many people as other uses of federal monies. Next year's budget, if used to employ people at the minimum wage, could provide minimum employment for nearly 24 million people--about 25% of the US work force. Few would argue that this use of government raised revenues would be "good" for the economy. In terms of employment in the private sector approximately 28,500 jobs are created per billion dollars of spending--more than 2.2 million all together. In the case of direct government hires, including military personnel, 35,000 people are employed per billion dollars of expenditures--thus an additional 3 million people

DEFENSE ECONOMIC IMPACT MODELING SYSTEM STRUCTURE

FIVE YEAR DEFENSE PLAN
HISTORICAL PERIOD PLUS FIVE YEAR FORECAST
TOA



DEFENSE OUTLAYS (1972 \$s)
TOTAL EXPENDITURES YEARLY BY BUDGET CATEGORIES



DEFENSE FINAL DEMAND TRANSLATOR
TRANSLATES OUTLAYS BY BUDGET CATEGORY INTO A SINGLE
VECTOR SHOWING DEFENSE EXPENDITURES BY
403 INDUSTRIAL SECTORS FOR EACH BUDGET YEAR



INPUT TO DATA RESOURCES, INC.

- MACROECONOMIC MODEL
- COST FORECASTING MODEL
- INTERINDUSTRY MODEL
- EMPLOYMENT MODEL
- SKILL LEVEL MODEL
- STRATEGIC REQUIREMENTS MODEL

are employed. Defense employs directly and indirectly only about 5% of the US labor force. During World War II defense activities employed directly and indirectly at least 50 percent of our expanded labor force.

Defense procurement also tends to be concentrated in more capital intensive sectors, thus it is not surprising that the rate of productivity growth in defense intensive activities is forecast to be 20% greater than in the economy as a whole; while output per employee in defense activities is fully 22% greater with the gap widening each year (\$74,100 for defense as compared to an economy-wide average output per worker of just \$60,400).

One key finding of the last year's Symposium was that a steady growth would probably be better for the economy than on-again, off-again growth, in DoD outlays. So long as business plans well for the increased levels of defense expenditures, then there will be more competition, more capitalization, and a lesser inflationary impact. Chart 3 illustrates why the Department of Defense has appeared, to many US firms to be a less than secure source of such steady demand. Over the past three decades defense spending has peaked and troughed, rising and falling in great sweeps. A part of our current capacity problems can be traced to the variability in defense spending that has forced many smaller, marginal supplies out of the market all together. Few, but the largest prime contractors, allow their defense share of total business to rise above 25% even in face of increasing defense demands. Over dependence on such defense business can, as history has shown, be risky.

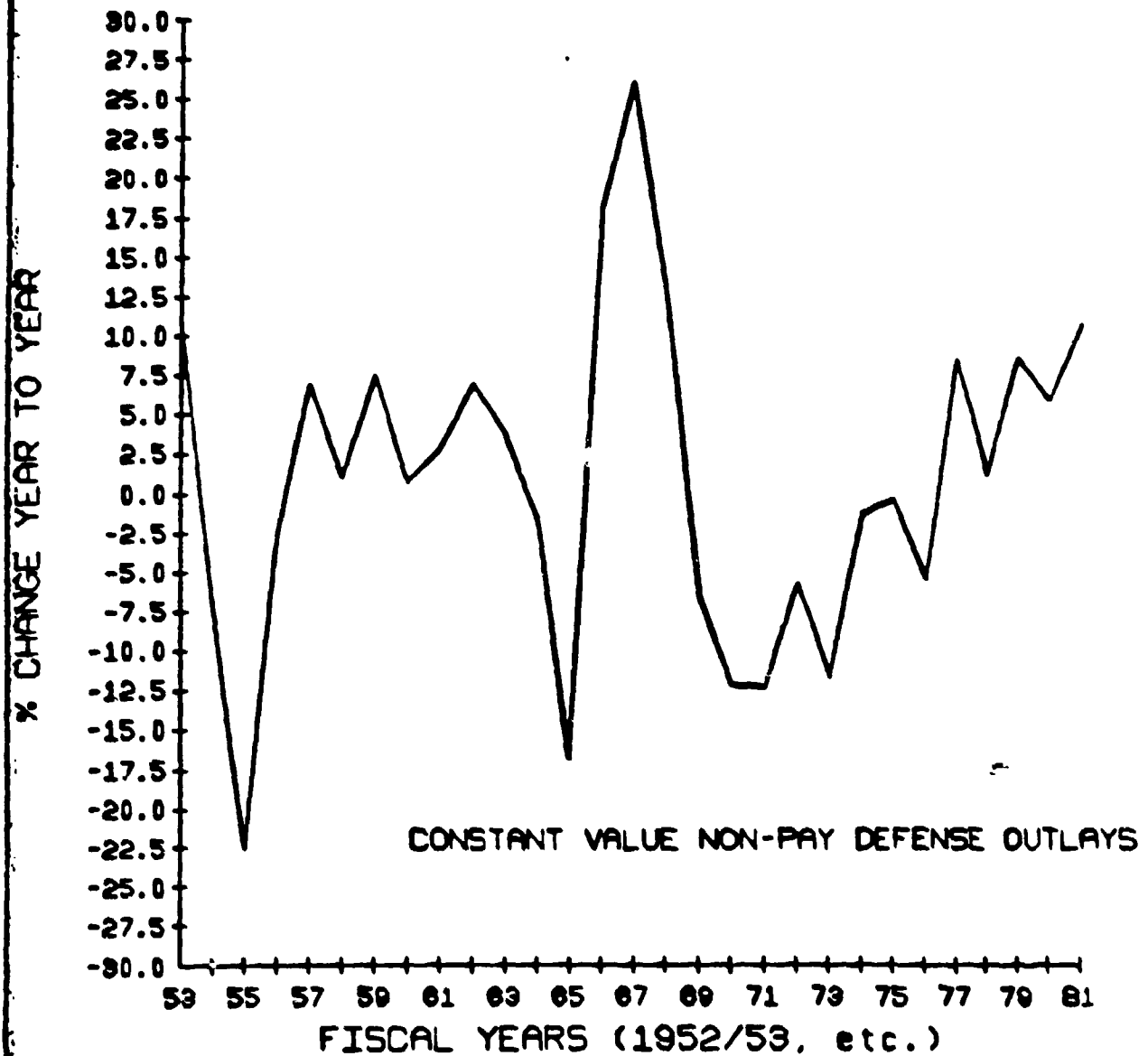
Yet given perceptions as to the problems now faced by America and its allies in the world today, it is likely that the defense market will continue to grow in the years to come. The forecasts for 1982 and beyond are for a real growth rate of at least 7% in outlays, even assuming some significant cuts are made in the original Reagan program. A 5% real growth, if sustained, would go a long way towards stimulating the United States economy especially in the new "core" sectors so important to America's future -- aerospace, industrial machinery, computers, program softwares, industrial electronics, and electro-mechanical optics.

Finally, changes in procurement codes, simplification of the paperwork jungle that many smaller contractors find themselves caught up in, and better projections as to our future requirements should encourage more participation in the defense market and greater competition. The final outcome will be a better prepared US industrial-base capable of fending-off foreign competition, as well as exporting goods and services to the emerging markets of Asia, Africa, the Middle East and Latin America. It is not simply coincidental that those sectors of the US economy so far able to compete best on world markets -- commercial aircraft (DoD share 39% to 57%); micro-computers and semi-conductors (9% to 15%); and industrial electronics (33%) -- are also those selling significant amounts to the Department of Defense.

CHART 3

UNCLASSIFIED

YEAR TO YEAR GROWTH IN NON-PAY DEFENSE OUTLAYS
CONSTANT \$5
1952 - 1981



UNCLASSIFIED

Human Capital Requirements

Critics of the proposed build-up cite the problem of obtaining sufficient skilled labor to work on increasingly complicated defense programs. One important modeling capability included in the Defense Economic Impact Modeling System is a special skilled-labor requirements model. It integrates Bureau of Labor statistics skilled labor estimates with defense and non-defense employment forecasts by sector. Thus industry-wide requirements for skilled labor--everything from aeronautical engineers to secretaries - can now be predicted. It is my belief that if we can give enough warning schools and training programs will provide the trained personnel to government and to industry.

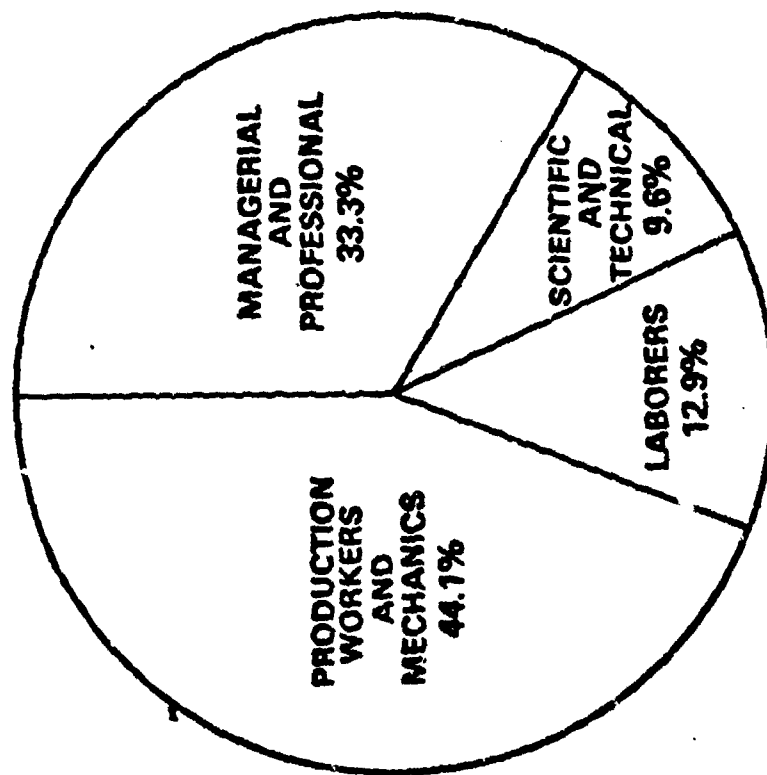
Chart 4 provides an overview of distribution of skilled labor requirements associated with the original Carter program for defense expenditures. While it is true that defense employs a disproportionate number of scientific and technical workers--10% of its total private sector employment as compared to 3% for non-defense employers, our share in 1980 of total non-government employment in this skill category employment was just 9%. Similarly, defense takes more skilled production workers--9% of our total employment compared to 5%; and more industrial operatives--31% compared to 21%. Still defense's share of total civilian employment in these categories was just 2% and 4% respectively.

Will we produce enough skilled workers to meet our requirements? Frankly, I do not know. I do know, however, that today enrollment in schools of engineering and science is at a peak as job security in the soft sciences has lessened, all the while demand for harder science skills has grown apace. There is no way that I can assure you that the numbers graduated will be adequate to fulfill the requirement or that my estimate is even correct. Nor can I answer the question as to how we can possibly produce the next generation of scientists, engineers, computer programmers, accountants, artists, and writers, without as much federal support of college education for the middle class as we have enjoyed in the very recent past. I think, however, that in the future individuals, and private industry, will have to pay more, than in the past, for the training of the next generation of skilled workers.

I think it is important to point out that the federal government, mainly through Department of Defense programs, has been and will continue to be a major supporter of high risk, basic research conducted on college and university campuses. Out of the \$4.3 billion in basic research performed there in 1980 the federal government share came to \$3.1 billion. Of the \$1.5 billion in applied research performed by academic institutions, the federal contribution was over \$800 million. Federal government funds were used to pay for scholarships and fellowships for graduate students, grants for professors, and new equipment for laboratories and research institutes. Our aim, aside from obtaining the needed research was, and is, to insure that the nation will have an adequate number of well trained scientists and engineers available to teach the next generation of college students, as well as to meet the challenges of the 1980's and beyond.

SHARE OF NON-GOVERNMENT WORKFORCE IN 1980 BY MAJOR SKILL CATEGORIES

DEFENSE



NONDEFENSE

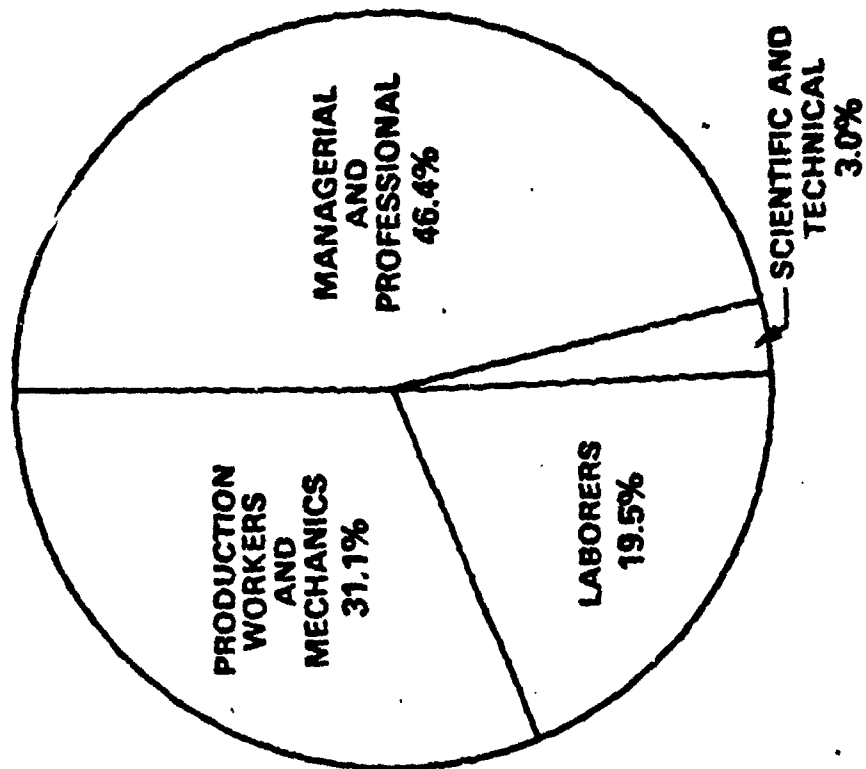


CHART 4

There is one final question I might answer while on the subject of the human capital resources needed in the years to come. The common wisdom of today is that the United States is behind the rest of the world in both science and technology. Other countries are graduating more, relative to the size of their populations, students trained in these specialized skills. The Soviet Union, for example, is assumed to be turning out more than 250,000 engineers a year compared to roughly 50,000 graduates in the US. But numbers often are misleading indicators of the true balance. Automation, even in the technical fields, has allowed people to be replaced, in part, by machines. Plans can be tested using computer models; and metal parts and dies can be cut or formed using machine-developed instructions relayed to numerically - controlled-machine tools. The Soviets have substituted, not by choice but by necessity, human capital for machine capital. Under such circumstances then the 50,000 new American-trained engineers may be fully capable of meeting the challenges posed by rapidly changing technologies.

The Mystique of Defense Spending

I am sure that I have not convinced everyone that defense spending is a necessary economic component of US final demand. Defense spending today does not simply play a role in assuring a measure of national security in a very insecure world, it also is important to the economy as a whole. For better or for worse, the US economy is adapted to and depends upon defense business.

I have tried in paper to highlight the steps we are taking to provide proper warning as to our requirements to private industry, to universities and to colleges, and to the financial markets. The Defense Economic Impact Modeling System should go a long way towards identifying the fastest growing sectors of our economy for special attention and its goal of encouraging better medium to long range planning in industry, in government, and in universities is a proper one. Our objective is simply to spur private competition for defense business at the level of the primes and their sub-contractors.

There still remains to be disposed of the mystique of defense spending as well as the related issue that such expenditures are somehow magically inflationary. The reason for this is that the myth that relates defense spending to economic waste is rooted primarily within our moral consciences. The Old Testament admonition that "thou shalt beat they swords into plowshares and they shields into pruning hooks and nations shall not make war anymore" is a strong one and basic to our morality. The God of Abraham, Isaac, and Jacob wasn't, however, by any means a pacifist when it came to protecting Israel's interest. Aside from the religious issue, there is also the ingrained economic belief that defense spending must be some special form of economic waste. While I cannot and do not wish to shake your moral beliefs, for they are my own as well, I do wish to take on the myth that defense spending is somehow a uniquely perverse use of economic resources.

The Myth of the Vanishing Defense Resource involves the heart and soul of economics itself. It is based almost entirely upon a belief that free markets somehow arrive, correctly I might add, at the best exchange of scarce resources between buyers and sellers. Thus the purchase of defense-type goods by the government is assumed to immediately reduce the quantity of goods available for private consumption, while the pay of defense workers maintains demand for consumer-type goods. The markets are then assumed to become choked with excess final demand coming from workers making jet engines for fighter aircraft rather than dishwashers. As a result prices are assumed to rise.

Advocates of the myth use the Vietnam War as their test case. There is no doubt that the added demand due to Vietnam, the tax cut of 1962-63, the Great Society Programs of the late 1960's, and the worldwide boom in trade and commodities of 1972-73, all contributed to the increase in wholesale and retail prices experienced in the United States starting in 1963. Between 1960 and 1963 the average yearly increase in inflation was just about 1%. Between 1964 and 1973 the average increase was 4%. When the price of oil increased fourfold between 1973 and 1974, the inflation rate increased from 6%--1972 to 1973 to more than 10%--1973 to 1974. Yet over much of this period--1968 to 1974, real expenditures on defense were declining from their wartime highs.

My real difficulty with the myth is not the simplistic causality it supposes. It is clear that if there actually were truly free markets for goods and services, if entry into producing goods and service sectors were absolutely free, if all goods were themselves perfect substitutes for all other goods, and if capital and labor skills were mobile between businesses, then taking resources from one part of this homogeneous market and utilizing these resources for defense purposes must lead to prices rising quickly. To come to this conclusion, however, we also should assume there is little productivity growth in the economy and that there are no excess supplies of either labor or capital available. Fortunately, the real world is significantly more complicated than this simplistic notion allows for.

Alternative Uses of Economic Resources

Why is building fuel inefficient and unsold (except at deep discounts) automobiles not a waste of scarce economic resources, while buying more fighter aircrafts, tanks, or ships is considered a waste? How can we truly tell, in today's diverse and changing market place, what is absolutely needed by society and what is not? Products sold today are differentiated by more than simply price, and it is often difficult to sort out "good" from "bad" uses of scarce economic resources. The free market is not morally pure. Supply can, through advertising, create demand for unwholesome and stupid products. Nor is the free market such a good judge of character so that investors money is always well or wisely spent. Along with profitable and beneficial investments are many unprofitable and even illegal ones.

In America today roughly 70% of our gross national product is now produced by the service sector. For services there is an even fuzzier line delineating what will be sold and what will not. People pay for quality, but measuring quality is a difficult task as it requires the individual buyer to make value judgments. The "free market" in America today has decreed that football players are worth more to the economy than college professors or Noble Laureates.

The question that must be answered is why is consuming football players services a better use of our economic resources than consuming defense type goods. Why should we categorically accept the argument of some that spending economic resources on one class of goods or services, say those used by the Department of Defense, is worse than another? Why is spending money on one not considered inflationary while spending on another is? Would inflation go away if we eliminated growth in defense spending? Would it go away if we eliminated professional football? The macroeconomic models suggest that this is not the case. The reason, I think, is that defense spending today is part and parcel to the fabric of the economy, and that basic structure changes slowly and adaptively.

We know that productivity comes both from the better use of capital and by utilizing even inefficient plants more fully. Cyclical elements in productivity growth generally outweigh those due to changes in capital available and the technology of production. Thus if we fail to utilize the US industrial plant, fail to maintain high levels of output in well endowed, fully capitalized plants, then US productivity growth will decline and prices will increase. Cutting defense spending without an equal increase in private demand for American-made goods--not more imported cars or television sets--will not reduce the inflationary biases built into today's economy. In today's economy, with its differentiated production facilities and differentiated labor force, inflation may be as much a product of our failing to fully utilize our productive plant and human capital well, as it is the result of our using such facilities too well.

Finally, those who argue that spending on defense is a waste assume that the problem is one of scarcity. In my own opinion the problem is one of confidence in the future. Today there is sufficient capacity in the machine tool industry in America to support a growing, dynamic, open-ended economy. But without confidence that business volume growth will be sufficient, companies selling differentiated products will price their goods defensively to cover, at a lower volume of production, their fixed overheads. The result is, I am afraid, stagnation, inflation, and pessimism.

Productive Resources Are Not Perfect Substitutes

The myth of the Vanishing Defense Resource depends upon a belief that all productive resources in an economy are easily transformed so that they may be employed to produce goods now in greater demand. Such a simplified production function, for a modern firm, is nothing more than a conjurers trick. It is not a realistic assessment of today's pattern of production.

Firms are specialized; and they react, and can react, only slowly, oftentimes ponderously, to changing markets. Recent business history is strewn with the wreckage of executives (and their firms) that have hastily diversified away from proven lines of business and into new, less well known markets and technologies.

In a supply-side world, where supply can create its own demand, who then can say what is needed and what is not; or what is absolutely necessary and what is not. It is a topsy-turvy world we face, and the market place is filled with useless items--some are sold, some are not sold, and some should never have been produced.

Defense Expenditures Are Part Of Our Economic Landscape

Defense expenditures are today an important part of our economic landscape. In the forty years since the war, we have developed an economic system that has within its structure a sizable defense-industrial base. Europeans view expenditures on defense less from their usefulness as means to defend their territories--they depend upon our good graces for that; and more as means to insure jobs and a growing base of new technologies on which their future prosperity depends. Americans tend to view defense as a sacred mission whose economic effects are an evil that we must somehow learn to live with. Yet in America, at least, defense is an important constituent part of our very complicated, sometimes dynamic, technologically-oriented economy.

As Defense spending is part, and parcel, to the fabric of our economy so too is technology married as an integral part of our emerging weapons systems. This marriage of convenience is justified on two grounds--it is the only way to match the Soviets numerical superiority; and it insures that new defense goods will be drivers in the technological base on which future American growth and prosperity depend. In the view of some, the Soviets quest for arms control limitations is less out of a concern that they would not be capable of maintaining their numerical superiority, but rather that new advances out of Western laboratories could well outdate their already heavy investments in military equipment.

Defense expenditures in the United States, in Europe, and even in Japan, can thus be viewed as a necessary part of our existing economies. Increasing levels of expenditure force the pace of progress by encouraging experimentation with new concepts--with government's money, not with industries. Business today is often shortsighted with respect to spending its own, or borrowed funds, at high interest rates on sometimes risky basic research projects. And basic research, unless oriented towards attaining nearly impossible goals, is in my opinion unlikely to be directed enough, or inspired enough, to accomplish such goals through the radical innovation. Finally, without radical innovation, Western civilization, built as it is on a dwindling resource base, will stagnate and decline.

It is unfortunate that private sector requirements are generally less demanding than those of the public sector, especially the Department of Defense, the Department of Energy, or the National Aeronautics and Space Administration. I think it is probably very difficult to inspire your best, most innovative designers and engineers, by offering them the opportunity to redesign next year's dishwasher models. When goals are set high enough, however, the human spirit is let free to wander upon the frontiers--in tomorrow's markets, not today's.

We often mistake Japanese industrial success in many technical areas as purely the result of their leading firms aggressive commercial drive and better planning. We tend to ignore the positive influence that the Japanese government ministries have on forcing the pace of technical progress by managing closely intra-firm competition, foreign access to the Japanese market, as well as by direct financial subsidization. The interest that Japan has shown in new, American military technology development is not without good reason--military technology is often the driver for the commercial products of the future. The unwillingness of Tokyo to share with the US its own technological achievements is a clear indication of the substitutability of defense and commercial technologies in today's marketplace.

New Design and Production Techniques

Perhaps the most important contribution that current defense expenditures are likely to make to future American prosperity is in the area of computer-aided design and manufacturing. Small unit buys for defense products (sometimes under 100 items at one time) have forced more emphasis on maximizing efficiency for small lot production and design. Also, the complexity of defense programs means that there is a need for specialized designing techniques that maximize the use of machine capital, thus minimizing the drain on skilled manpower, often in short supply. US prime defense contractors, by and large, operate using highly automated plants and equipment both in design and in production. Most of the major new CAD/CAM systems being introduced in US industry were originally designed by or for major prime contractors. Aerospace firms and industrial electronics ones are today at the forefront of US industry's efforts to automate more fully production processes in order to compete more vigorously with Japan on global and US markets. While the cost of new capital may be high, the gains in efficiency can often be significant. For example, using CAD/CAM systems to design and build turbine blades for jet engines--a demanding and time consuming task in the past--cuts the design time by a factor of five to one, and the production time by a factor of anywhere from 30 to 1 to 50 to 1.

The Department of Defense has encouraged this push towards automation in industry through various special research and development programs, as well as via direct subsidization of new machinery and equipment. Our pay-off has been reduced unit costs. Also more automated equipment opens

greater possibilities of surging to meet higher production rates in the event of a national emergency. Through specialized programs--such as the DOD technology modernization effort in the aircraft and electronics industry or our program to design and develop, for military and commercial benefit, Very High Speed Integrated Circuits, we are paying for the development of new approaches to design and production that will revolutionize the production process in America within a single life time.

It is easy to suggest that much of the defense technology would have eventually been developed by the private sector. Yet private firms have not invested heavily in basic or pure research. Aside from new technologies for telephone communications--developed I should add by and for a private monopoly--much of the research and development of very small, and consequently very fast, micro-computers and their memories, has been a by product of the requirements levied by defense and space applications. The willingness of the government to pay for primary research is a major technology driver in many of our large firm's research and development budgets. While defense may start the process of technological change rolling, it is still the responsibility of the private sector to commercialize and to extend the progress by introducing such new technologies into civilian or industrial goods or service applications.

Maintains the Human Resources Base

Defense today is an important component of final business demand in our technologically-oriented economy. Our emphasis on newly designed or improved equipment helps to maintain nation's stock of scientific and technical resources intact (the fall-off in new DoD systems orders that occurred in 1970-72 led to a recession for the engineering and scientific community until the government redirected its spending into basic energy research in the post-1974 period). Through specialized programs with universities, we insure that such scarce and irreplaceable scientific and technical resources will be available to the nation for other uses.

The free market, I believe, if left entirely on its own, is unlikely to maintain such a rich stock of talent, nor such well maintained and equipped laboratories. Stockholders, and cost accountants, generally are not that free with corporate financial resources, and alas the rigors of cost accounting often preclude allocations to projects which may not yield commercial products in the short-run. It is no wonder then that much of the industry sponsored research and development carried out in America today is performed by firms that have sold, are selling, or plan to sell at least some of their company's outputs to the Department of Defense, NASA, or the Department of Energy. Such technology intensive companies are thus able to share the burden of their highly trained, and

highly paid, research staffs with the government. This is good for the companies, for the government, and for the country as a whole.

A Legitimate Function Of Government

I believe that if we can ever enter a world free of all distrust, a world where there is no need for building forces to be used as deterrence against possible aggression or intimidations, then we will be forced to create new challenges that will spur technical competition among nations. It is too easy to protect national markets against change through tariff barriers, quotas, and oligopolistic business practices. Protected markets limit technical progress and innovation by insuring that international competition is constrained. If such a peaceful world were possible, it would fall to the government then to find new challenges.

Nations, like companies, are spurred on by such challenges and such competition. Scientific discovery is as much the byproduct of supportive government as it is of human creativity and genius--who but governments, kings, or princes could afford the luxury of the Italian Renaissance or the development of the microprocessor chip. The promotion of research and development by government is perhaps one of the best examples of an area where government programs, far from being the problem, are part and parcel of the solution itself.